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THE CANADIAN AIDS TO NAVIGATION SYSTEM



Canada

AIDS AND
WATERWAYS
DIRECTORATE

THE CANADIAN AIDS TO NAVIGATION SYSTEM

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WATERWAYS
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NOTICES

1. Mariners are requested to immediately report any failure of a marine aid to navigation to the nearest Canadian Coast Guard office or to a Coast Guard Radio Station or Traffic Centre (see page 33).
2. In January 1990 The Canadian Coast Guard introduced an "Isolated Danger Buoy" into the Canadian aids to navigation system. (See page 12 and the center insert for details of this new buoy).
3. The Canadian Coast Guard is presently installing a new "Oscillating Boundary Sector Light" at some sites across Canada. Information concerning the establishment of, or conversion to, these lights will be issued through Notices to Mariners. (See page 9 and the center insert for details of this light).

INTRODUCTION

GENERAL

Definition

Aids to Navigation are devices or systems, external to a vessel, which are provided to help a mariner determine his position and course, to warn him of dangers or obstructions or to advise him of the location of the best or preferred route.

Responsibility

The Canadian Coast Guard, which is part of the Department of Transport, is responsible for the provision of aids to navigation in Canadian waters with the exception of the Trent-Severn and Rideau waterways, which are served by Parks Canada, Department of the Environment.

Other Publications

Aids to Navigation are to be used in conjunction with available marine publications including nautical charts, Lists of Lights, Buoys and Fog Signals, Radio Aids to Marine Navigation and Sailing Directions, for proper understanding and interpretation of their function. Information concerning nautical charts and Sailing Directions may be obtained from the Canadian Hydrographic Service, Department of Fisheries and Oceans, Ottawa. (See Page 32).

The Canadian Aids to Navigation System

The Canadian Aids to Navigation system is a combined Lateral-Cardinal system. A knowledge of the characteristics of each of these basic types of aids is a prerequisite to the safe use of the system.

Lateral Aids to Navigation

Lateral aids may be in the form of either buoys or fixed aids. These aids indicate the location of hazards and of the safest or deepest water by indicating the side on which they are to be passed. The correct interpretation of lateral aids requires a knowledge of the direction of buoyage known as the "upstream direction". The upstream direction is the direction taken by a vessel when proceeding from seaward, toward the headwaters of a river, into a harbour or with the flood tide. In general, the upstream direction is in a southerly direction along the Atlantic Coast, in a northerly direction along the Pacific Coast and in an easterly direction along the Arctic Coast. In some waters the upstream direction is indicated on the charts by the use of lines and arrows.

When a vessel is proceeding in the upstream direction, starboard hand aids must be kept to starboard (right) and port hand aids must be kept to port (left).

Cardinal Aids to Navigation

Cardinal aids may be in the form of either buoys or fixed aids; however, at present, their use is confined to buoys in the Canadian system.

Cardinal aids indicate the location of hazards and of the safest or deepest water by reference to the cardinal points of the compass. There are four cardinal marks, North, East, South and West, which are positioned so that the safest or deepest water is to be found to the named side of the mark (e.g. to the north of a north cardinal mark).

Winter Navigation

In many parts of Canada ice conditions in winter necessitate the removal of navigation buoys and the closing of navigation. The operation of navigation lights and fog signals on shore may also be discontinued during such times. In areas of less severe ice conditions the buoys used in summer are replaced by more rugged, but unlighted, winter buoys and navigation continues. Mariners are advised of the closing of navigation, of the seasonal removal or substitution of buoys and of the temporary discontinuance of other aids to navigation by local marine radio broadcasts and Notices to Shipping.

CAUTIONS IN THE USE OF AIDS TO NAVIGATION

1. Most aids to navigation are not under continuous observation and mariners should be aware that, with the many thousands of aids in Canada, failures and displacements do occur. The Coast Guard does not guarantee that all aids to navigation will operate as advertised and in the positions advertised at all times. Mariners observing lights out of operation or buoys, markers, etc., off charted position, damaged or missing are responsible for reporting such to the nearest Coast Guard Radio Station, Vessel Traffic Centre, Coast Guard office, or to the Chief, Marine Aids, Canadian Coast Guard, Ottawa.
2. Aids to navigation are subject to damage, failure or dislocation by ice or storms, to being struck by vessels or tows and to power failures. Ice and storm damage may be widespread and require considerable time to repair. Isolated damage may exist for a long time without being discovered and reported. Floating aids and pier lights in or near the water are exposed to particularly rigorous strain during ice movement.
3. Mariners are cautioned that buoys may fail to exhibit their advertised characteristics. Lights may be extinguished or sound signals may not function due to ice, collisions, mechanical failure and, in the case of bell and whistle buoys, calm water. The shape of a buoy may be altered by ice formation or damage. The colour of a buoy may be altered by freezing spray, marine growth or fouling by birds.
4. Mariners are cautioned not to rely solely on buoys for navigation purposes. Navigation should be by bearings or angles from fixed shore aids or other charted landmarks and by soundings whenever possible.
5. The buoy positions shown on government charts should be considered only approximate positions. There are a number of limiting factors in accurately positioning buoys and their anchors, such as prevailing atmospheric and sea conditions, tidal and current conditions, seabed conditions and the fact that buoys are moored to anchors by varying lengths of chain and may drift about their charted positions within the scope of their moorings.
6. Since moving ice is liable to move buoys from their advertised positions, mariners should proceed with extreme caution under these circumstances.
7. Mariners are reminded that grids of charts of an area may vary from one chart to another. When plotting the positions of aids by the latitude and longitude method, the results should be checked against other available information.

8. In some instances where it is necessary to establish a buoy in close proximity to or on a navigational hazard, i.e., shoal, reef or ledge, etc., the buoy symbol may be off-set slightly on the chart in the direction of the preferred navigable water so that the existing hazard depicted on the chart will not be overprinted by the buoy symbol.
9. Mariners are cautioned not to navigate too closely to a buoy and risk collision with it, its mooring or with the underwater obstruction which it marks.
10. Many lights are equipped with sun switches that turn the lights off in daylight. These lights, both ashore and on most buoys, are unlit between sunrise and sunset. Mariners unable to see these lights during the daylight hours should not assume that the equipment is not functioning normally.
11. At some lightstations, winter lights equipped with sun switches are operated when the main lights are decommissioned for the winter months. A winter light does not necessarily exhibit the same characteristics as the main light and has reduced intensity. The characteristics of a particular winter light and its season of operation are noted in the 'Remarks' column of the List of Lights, Buoys and Fog Signals.
12. Major lightstations which exhibit the main light 24 hours per day are equipped with an emergency light which is brought into service automatically throughout the hours of darkness in the event of failure of the main light. These emergency lights are white and have a standard character of group flashing (6) 15 sec., that is six flashes, each of 1/2 second duration, followed by a period of darkness (eclipse) of 7 seconds. Emergency lights are normally (on a dark night with a clear atmosphere) visible at 5 nautical miles. The List of Lights, Buoys and Fog Signals publications identify which lightstations are equipped with emergency lights.
13. Atmospheric conditions can have a considerable effect on light transmission and the visibility of lights. For example:
 - (a) The distance of an observer from a light cannot be reliably estimated from its apparent brightness.
 - (b) At night it is difficult to distinguish between a white light and a yellow or blue light seen alone, except at a short distance.
 - (c) Under some atmospheric conditions white and yellow lights may take on a reddish hue.
 - (d) Alternating lights with phases of different luminous intensity may change their apparent characteristics at different distances because some phases may not be visible.
 - (e) Weak lights are more easily obscured by conditions of low visibility than more powerful lights. Coloured lights are also inferior in intensity to white lights and are more quickly lost under unfavourable circumstances.
 - (f) During cold weather, and more particularly with rapid changes of weather, ice, frost or moisture may form on the windows of lantern houses, thereby greatly reducing their visibility and possibly causing coloured lights to appear white.
 - (g) A light exhibiting a very short flash may not be visible at as great a range as a light exhibiting a longer flash.

14. The mariner should not rely solely on colour when using a sector light, but should verify his line of position by taking a bearing on the light. On either side of the line of demarcation, between white and red, and also between white and green, there is always a small arc of uncertain colour.
15. When the arc of visibility of a light is cut off by sloping land, the bearing at which it disappears or appears will vary with the observer's distance and height of eye.
16. The sighting of a light may be adversely affected by a strongly illuminated background.
17. In view of the varying distances at which a fog signal can be heard at sea, and the frequent occurrence of fog near, but not observable from, a fog signal station, Mariners are cautioned that:
 - (a) While every endeavour will be made to start fog signals as soon as possible after signs of fog have been detected, they should not, when approaching the land in a fog, rely implicitly upon these fog signals, but should always take soundings, which, in nearly all cases, will give sufficient warning of danger.
 - (b) They should not judge their distance from a fog signal by the power of the sound. Under certain atmospheric conditions the sound may be lost at a very short distance from the station, and these conditions may vary within very short intervals of time. Mariners should not assume that a fog signal is not in operation because they do not hear it, even when in close proximity to it.
18. The visual aids to navigation (e.g. lights) provided by the Coast Guard are for the purpose of assisting marine navigation. Hunters, snowmobilers and ice fishermen are cautioned that aids to navigation installed for marine navigation purposes cannot be relied upon after the close of the marine navigation system. Such aids may stop operating without warning and will not be recommissioned by the Coast Guard until the next opening of marine navigation.

AIDS TO NAVIGATION PROTECTION REGULATIONS*

Regulations have been enacted, under the Canada Shipping Act, to protect Canadian aids to navigation from wilful or neglectful damage and thus to ensure the availability of the important service which they provide. These Regulations, which are called Aids to Navigation Protection Regulations, are as follows:

1. These Regulations may be cited as the Aids to Navigation Protection Regulations.
2. In these Regulations "aid to navigation" means a buoy, beacon, lighthouse, lightship or any other structure or device installed, built or maintained for the purpose of assisting the navigation of vessels.
3. (1) The person in charge of any vessel or tow that, through accident or unavoidable circumstances, runs down, moves, injures or destroys an aid to navigation shall report the fact to the nearest District Manager (or any other office), Canadian Coast Guard, by wireless telegraphy or radio telephone via the nearest coast radio station, commercial telegram or telephone or in person as soon as practicable.
(2) Every person who is required by subsection (1) to report to a District Manager, Canadian Coast Guard, and who fails to report as soon as practicable by the means prescribed in subsection (1) is guilty of an offence and is liable on summary conviction to a fine not exceeding fifty dollars.

* Note: The Aids to Navigation Protection Regulations are presently under review.

4. Every person who wilfully or negligently injures, conceals, removes, alters or destroys an aid to navigation is guilty of an offence and is liable on summary conviction to a fine not exceeding two hundred dollars.

PRIVATE AIDS TO NAVIGATION

In Canada it is permissible for private individuals, clubs, corporations or other groups to provide aids to navigation for their own use. Such aids to navigation are known as "private" aids and those that are advertised in the Lists of Lights and on the Charts are so identified. While private fixed aids may take a variety of forms, all private buoys must conform to the Private Buoy Regulations. These Regulations describe the colour, shape, size and markings required for each buoy as well as the responsibilities of the person(s) placing them. The requirements for the colour and shape of private buoys as well as their placement and use are the same as those for buoys provided by the Canadian Coast Guard. However, the identification markings used must conform to the Private Buoy Regulations rather than to the number and letter identification system used by the Coast Guard.

FIXED AIDS TO NAVIGATION

LIGHTSTATIONS

General

Lightstations are fixed structures equipped with a light and located at prominent sites to assist the mariner to fix his position. They may be at or near shorelines or on built-up man-made piers in or near waterways.

Types

The types and shapes of lightstation structures used in Canada are varied. They may have vertical or tapering sides, may be circular, square, polygonal or octagonal in section, and may be constructed of wood, masonry, concrete, metal or fibreglass. They may be slender cylindrical structures such as pipes or poles or open skeleton towers.

Characteristics

The characteristics of fixed aids are for identification purposes. They consist of the light colour and flash character by night and the colour and shape of the structure by day (daymark), as advertised in the appropriate List of Lights, Buoys and Fog Signals publication. The structure colour(s) of a major lightstation are often selected for maximum conspicuity and ease of identification and may not have lateral significance.

Lateral Significance

When proceeding upstream, fixed aids displaying a red triangular symbol in the centre of the daymark or a single red band at the top of the tower must be kept on the vessel's starboard (right) hand. Fixed aids displaying a black or green square symbol in the centre of the daymark or a single black or green band at the top of the tower must be kept on the vessel's port (left) hand.

Fixed aids displaying an open-faced red diamond symbol in the centre of the daymark indicate a division in the channel and may be passed on either side. However, when proceeding upstream, a red triangle in the centre of the red diamond indicates that the preferred route is to the left (i.e. the aid should be kept on the vessel's starboard (right) side). Similarly, a black or green square in the centre of the red diamond indicates that the preferred route is to the right (i.e. the aid should be kept on the vessel's port (left) side).

DAYBEACONS

General

Although the majority of fixed structures support and display a light for night navigation, a limited number do not. These unlit aids are known as daybeacons and are used primarily to assist the mariner during daylight hours where night navigation is negligible or where it is not practicable to operate a light.

Colour, shape and possibly a number are the characteristics which identify the significance of a daybeacon to the mariner. Reflective material is applied to the daybeacons to improve their conspicuity and identification at night with the aid of a searchlight.

Starboard Daybeacon

A starboard hand daybeacon is triangular, with a red triangular centre on a white background and with a red reflecting border. It may display an even number made of white reflecting material. When proceeding upstream, a starboard hand daybeacon must be kept on the vessel's starboard (right) side.

Port Daybeacon

A port hand daybeacon is square with a black or green square centre on a white background and with a green reflecting border. It may display an odd number made of white reflecting material. When proceeding upstream, a port hand daybeacon must be kept on the vessel's port (left) side.

Bifurcation/Junction Daybeacon

A bifurcation/junction daybeacon marks a point where the channel divides and may be passed on either side. When proceeding in the upstream direction, a bifurcation/junction daybeacon displaying a red reflecting triangle on a white diamond with a red border indicates that the preferred route is to the left. Similarly a green reflecting square on a white diamond with a red border indicates that the preferred route is to the right. When proceeding downstream, the positions and meanings of these daybeacons are reversed.

FOG SIGNALS

General

Fog Signals are sound-producing aids that warn of dangers when visual aids are obscured by weather conditions.

Operation

Fog signals are normally operated when weather conditions are such as to reduce the visibility to less than two nautical miles. However, other values may be assigned because of local noise abatement laws or local operational requirements.

While most fog signals are operated manually or automatically by fog detection equipment in response to a low visibility condition, some fog signals may be operated continuously.

Characteristics

The mariner can identify fog signals by their distinctive sound and signal characteristics as advertised in the appropriate List of Lights, Buoys and Fog Signals publication.

SECTOR LIGHTS

General

A sector light consists of a single light whose total luminous beam is divided into sectors of different colours to provide a warning or a leading line to mariners. The colours and boundaries of these sectors are indicated in the appropriate List of Lights, Buoys and Fog Signals publication and on marine charts.

Characteristics

When only a red sector is used within a white luminous beam, the red sector marks obstructions such as shoals.

A combination of red, white and green sectors in a luminous beam is used to provide a leading line to navigators.

When proceeding upstream, the red sector indicates the starboard hand limit, the white sector indicates the recommended course, and the green sector indicates the port hand limit. When proceeding downstream the positions of the red and green sectors are reversed.

Sector Lights with Oscillating Boundaries

Some sector lights may be equipped with an oscillating boundary feature. This creates additional "boundary sectors" between solid sectors. Within these boundary sectors the rhythm of the alternating light colours will give the observer a visual indication of his position.

The most common application of this feature is with the three colour (red/white/green) leading line sector light, however, the mariner should consult the chart and other publications for the proper interpretation and usage of each light.

Example: When proceeding upstream and crossing a 3 colour oscillating boundary sector light marking an upstream course from left to right, the observer would see, in order:

G - Solid green.

AIGW - Green and white, alternating every 3 seconds. The duration of white would be brief when first entering the boundary sector but would become progressively longer as the observer crosses towards the white sector.

W - Solid white.

AIRW - Red and white alternating every 3 seconds, the period of red being brief when first entering the boundary sector. As the observer crosses towards the solid red sector the period of time for which red is seen increases.

R - Solid red.

When proceeding downstream and crossing a 3 colour oscillating boundary sector light marking a downstream course, from left to right, the order of the colours would be reversed. i.e.: R-AIRW-W-AIGW-G

RANGES

A range consists of two or more fixed navigation marks situated some distance apart and at different elevations to provide a leading line for navigators. Ranges may or may not be lighted. If lighted, the colour of the range daymark as well as the colours and characters of the lights are advertised in the appropriate List of Lights, Buoys and Fog Signals publication.

BUOYS

In 1983 the Canadian Coast Guard introduced a new buoyage system in Canadian waters. This system, which was developed by the International Association of Lighthouse Authorities (IALA) and which has been adopted by all of the major maritime nations in the world, includes lateral, cardinal, and special buoys.

For lateral buoys, the IALA Maritime Buoyage System divides the world into two-regions, "A" and "B". Within Region "B", which comprises all of North and South America, Japan, the Republic of Korea and the Philippines, starboard hand buoys are red and port hand buoys are green. Within Region "A", which includes the rest of the world the application of these colours is reversed (i.e. red to port and green to starboard). Bifurcation buoys are similarly affected in that the predominant colour of starboard bifurcation buoys is red in Region "B" and green in Region "A" and that of port bifurcation buoys is green in Region "B" and red in Region "A". All other aspects of the IALA Maritime Buoyage System are the same in both Regions "A" and "B". (see page 22)

Since the shape and/or colour of a buoy and the colour and flash character of the light on the buoy indicate the function of the buoy, it is essential that mariners use up-to-date nautical charts with this system.

NAVIGATION BUOYS

LATERAL BUOYS

Lateral buoys indicate the side on which they may be safely passed. There are six types of lateral buoys: port hand, starboard hand, port bifurcation, starboard bifurcation, fairway, and isolated danger.

Port Hand Buoy

- (a) A port hand buoy marks the port (left) side of a channel or the location of a danger which must be kept on the vessel's port (left) side when proceeding in the upstream direction.
- (b) A port hand buoy is coloured green, displays identification letter(s) and odd number(s) and
 - (i) if it carries a light, the light is green and is a flashing (F1)4s or quick flashing (Q)1s light,
 - (ii) if it carries retroreflective material, such material is green,
 - (iii) if it does not carry a light, it has a flat top, and
 - (iv) if it carries a topmark, the topmark is a single green cylinder.

Starboard Hand Buoy

- (a) A starboard hand buoy marks the starboard (right) side of a channel or the location of a danger which must be kept on the vessel's starboard (right) side when proceeding in the upstream direction.
- (b) A starboard hand buoy is coloured red, displays identification letter(s) and even number(s) and
 - (i) if it carries a light, the light is red and is a flashing (F1) 4s or quick flashing (Q)1s light,
 - (ii) if it carries retroreflective material, such material is red,
 - (iii) if it does not carry a light, it has a pointed (conical) top, and
 - (iv) if it carries a topmark, the topmark is a single red cone, point upward.

Port Bifurcation Buoy

- (a) A port bifurcation buoy marks the point where a channel divides when viewed from a vessel proceeding in the upstream direction and indicates that the preferred or main channel is on the starboard (right) side of the buoy.
- (b) A port bifurcation buoy is coloured green with one broad red horizontal band, displays identification letter(s), and
 - (i) if it carries a light, the light is green and is a composite group flashing Fl(2+1)6s or Fl(2+1)10s light,
 - (ii) if it carries retroreflective material, such material is green,
 - (iii) if it does not carry a light, the top of the buoy is flat, and
 - (iv) if it carries a topmark, the topmark is a single green cylinder.

Starboard Bifurcation Buoy

- (a) A starboard bifurcation buoy marks the point where a channel divides when viewed from a vessel proceeding in the upstream direction and indicates that the preferred or main channel is on the port (left) side of the buoy.
- (b) A starboard bifurcation buoy is coloured red with one broad green horizontal band, displays identification letter(s), and
 - (i) if it carries a light, the light is red and is a composite group flashing Fl(2 + 1)6s or Fl(2+1)10s light
 - (ii) if it carries retroreflective material, such material is red,
 - (iii) if it does not carry a light, the top of the buoy is conical, and
 - (iv) if it carries a topmark, the topmark is a single red cone, point upward.

Fairway Buoy

- (a) A fairway buoy marks a landfall, the entrance to a channel or the centre of a channel.
- (b) A fairway buoy is coloured red and white in wide vertical stripes of equal widths, displays identification letter(s), and
 - (i) if it carries a light, the light is white and is either a Morse "A" Mo(A)6s light or a long flash (LFI)10s light,
 - (ii) if it carries retroreflective material, such material is white
 - (iii) if it does not carry a light, the top of the buoy is spherical, and
 - (iv) if it carries a topmark, the topmark is a single red sphere.

Isolated Danger Buoy

- (a) An isolated danger buoy is moored on or above an isolated danger which has navigable water all around it.
- (b) An isolated danger buoy is black with one broad red horizontal band, displays identification letter(s), and
 - (i) if it carries a light, the light is white and is a group flashing Fl(2)5s or Fl(2)10s light,
 - (ii) if it carries retroreflective material, such material is white,
 - (iii) if it does not carry a light, it is normally spar shaped although other shapes may be used,
 - (iv) if it carries a topmark, the topmark is two black spheres, one above the other.

CARDINAL BUOYS

Cardinal buoys indicate the location of the safest or deepest water by reference to the cardinal points of the compass. There are four cardinal buoys: North, East, South and West.

North Cardinal Buoy

- (a) A north cardinal buoy is located so that the safest water exists to the north of it.
- (b) A north cardinal buoy is coloured black and yellow in approximately equal areas above the waterline, the top half of the buoy being black and the lower half being yellow. It displays identification letter(s) and
 - (i) if it carries a light, the light is white and is a quick flashing (Q)1s or very quick flashing (VQ).5s light,
 - (ii) if it carries retroreflective material, such material is white,
 - (iii) if it does not carry a light, it is normally spar shaped although other shapes may be used, and
 - (iv) if it carries a topmark, the topmark is two black cones, one above the other, points upward.

East Cardinal Buoy

- (a) An east cardinal buoy is located so that the safest water exists to the east of it.
- (b) An east cardinal buoy is coloured black with one broad yellow horizontal band. It displays identification letter(s) and
 - (i) if it carries a light, the light is white and is a group quick flashing three Q(3)10s or a group very quick flashing three VQ(3)5s light,
 - (ii) if it carries retroreflective material, such material is white,
 - (iii) if it does not carry a light, it is normally spar shaped although other shapes may be used, and
 - (iv) if it carries a topmark, the topmark is two black cones, one above the other, base to base.

South Cardinal Buoy

- (a) A south cardinal buoy is located so that the safest water exists to the south of it.
- (b) A south cardinal buoy is coloured black and yellow in approximately equal areas above the waterline, the top half of the buoy being yellow and the lower half being black. It displays identification letter(s) and
 - (i) if it carries a light, the light is white and is a group quick flashing six plus long flash (Q(6) + LFI)15s light or group very quick flashing six plus long flash (VQ(6) + LFI)10s light,
 - (ii) if it carries retroreflective material, such material is white,
 - (iii) if it does not carry a light, it is normally spar shaped although other shapes may be used, and
 - (iv) if it carries a topmark, the topmark is two black cones, one above the other, points downward.

West Cardinal Buoy

- (a) A west cardinal buoy is located so that the safest water exists to the west of it.
- (b) A west cardinal buoy is coloured yellow with one broad black horizontal band. It displays identification letter(s) and
 - (i) if it carries a light, the light is white and is a group quick flashing nine Q(9)15s light or a group very quick flashing nine VQ(9)10s light,
 - (ii) if it carries retroreflective material, such material is white,
 - (iii) if it does not carry a light, it is normally spar shaped although other shapes may be used, and
 - (iv) if it carries a topmark, the topmark is two black cones, one above the other, point to point.

SPECIAL BUOYS

Special buoys are used to convey, to the mariner, a variety of information which, while important to him, is not primarily intended to assist in the navigation of his vessel. The shapes of special buoys have no significance and a variety of shapes may be used in practice.

Many special buoys are privately owned. As required by the Private Buoy Regulations such buoys must display the letters "PRIV" and the owners name, address and telephone number. They will not display numbers or letters conforming to the Coast Guard identification system.

Anchorage Buoy

- (a) An anchorage buoy marks the perimeter of a designated anchorage area.
- (b) An anchorage buoy is coloured yellow, displays a black anchor symbol on at least two opposite sides, displays identification letter(s) and
 - (i) if it carries a light, the light is yellow and is a flashing (Fl)4s light,
 - (ii) if it carries retroreflective material, such material is yellow, and
 - (iii) if it carries a topmark, the topmark is a single yellow "X" shape.

Cautionary Buoy

- (a) A cautionary buoy marks an area where mariners are to be warned of dangers such as firing ranges, racing courses, seaplane bases, underwater structures; of areas where no safe through channel exists and of traffic separations. The mariner must consult his chart to determine the precise nature of the danger being marked.
- (b) A cautionary buoy is coloured yellow, displays identification letter(s) and
 - (i) if it carries a light, the light is yellow and is a flashing (Fl)4s light,
 - (ii) if it carries retroreflective material, such material is yellow, and
 - (iii) if it carries a topmark, the topmark is a single yellow "X" shape.

Ocean Data Acquisition System (ODAS) Buoy

- (a) An ODAS buoy marks a scientific, meteorological or oceanographic station.
- (b) An ODAS buoy is coloured yellow, displays identification letter(s) and
 - (i) if it carries a light, the light is yellow and is a group flashing light of 5 flashes every 20 seconds, Fl(5)20s and

- (ii) if it carries retroreflective material, such material is yellow, and
- (iii) if it carries a topmark, the topmark is a single yellow "X" shape.

NOTE: ODAS buoys are governed by Rule 44 of the Collision Regulations, Canada Shipping Act.

Mooring Buoy

- (a) A mooring buoy is used for mooring or securing a vessel, seaplane, etc.
- (b) A mooring buoy is coloured white and orange, the orange colour covering the top one-third of the buoy above the waterline. It displays identification letter(s), and
 - (i) if it carries a light, the light is yellow and is a flashing (Fl)4s light, and
 - (ii) if it carries retroreflective material, such material is yellow.

Diving Buoy

- (a) A diving buoy marks an area where scuba or other such diving activity is in progress.
- (b) A diving buoy is coloured white and carries a red flag not less than 50 centimetres square with a white diagonal stripe extending from the tip of the hoist to the bottom of the fly. It may display identification letter(s) and
 - (i) if it carries a light, the light is yellow and is a flashing (Fl)4s light, and
 - (ii) if it carries retroreflective material, such material is yellow.

Note: A vessel engaged in diving or underwater operations must display the proper lights and signals as specified in Rule 27 of the Collision Regulations.

Keepout Buoy

- (a) A keepout buoy marks an area where boats are prohibited.
- (b) A keepout buoy is coloured white and has an orange diamond containing an orange cross on two opposite sides and two orange horizontal bands, one above and one below the diamond symbols. It may display identification letter(s), and
 - (i) if it carries a light, the light is yellow and is a flashing (Fl)4s light, and
 - (ii) if it carries retroreflective material, such material is yellow.

NOTE: Keepout buoys are governed by the Boating Restriction Regulations, Canada Shipping Act.

Control Buoy

- (a) A control buoy marks an area where boating is restricted.
- (b) A control buoy is coloured white and has an orange, open-faced circle on two opposite sides and two orange horizontal bands, one above and one below the circles. A black figure or symbol inside the orange circles indicates the nature of the restriction in effect. It may display identification letter(s) and
 - (i) if it carries a light, the light is yellow and is a flashing (Fl)4s light, and
 - (ii) if it carries retroreflective material, such material is yellow.

NOTE: Control buoys are governed by the Boating Restriction Regulations, Canada Shipping Act.

Information Buoy

- (a) An information buoy displays, by means of words or symbols, information of interest to the mariner.
- (b) An information buoy is coloured white and has an orange, open-faced square symbol on two opposite sides and two orange horizontal bands, one above and one below the square symbols. The information words or symbols are black and are placed within the white face of the square symbol. It may display identification letter(s), and
 - (i) if it carries a light, the light is yellow and is a flashing (Fl)4s light, and
 - (ii) if it carries retroreflective material, such material is yellow.

Swimming Buoy

- (a) A swimming buoy marks the perimeter of a swimming area.
- (b) A swimming buoy is coloured white, may display identification letter(s), and
 - (i) if it carries a light, the light is yellow and is a flashing (Fl)4s light, and
 - (ii) if it carries retroreflective material, such material is yellow.

DAYTIME IDENTIFICATION

During daytime, the colour and shape of a buoy indicate the buoy type and hence its function and interpretation by the mariner.

1. Buoy Colour

The following are the buoy colours used in the Canadian Buoyage System:

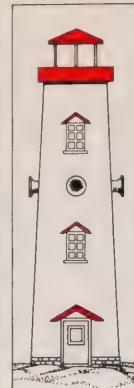
Buoy Type	Colour
Port	green
Starboard	red
Fairway	red and white vertical stripes
Isolated Danger	black with one broad horizontal red band
Port Bifurcation	green with one broad horizontal red band
Starboard Bifurcation	red with one broad horizontal green band
North Cardinal	black above yellow
East Cardinal	black with one broad horizontal yellow band
South Cardinal	yellow above black
West Cardinal	yellow with one broad horizontal black band
Anchorage	yellow
Cautionary	
ODAS	



THE CANADIAN AIDS TO NAVIGATION SYSTEM

Canada

LIGHTSTATION



LIGHT

A LIGHTSTATION IS A MAJOR AID TO NAVIGATION THAT DISPLAYS A MAIN LIGHT, IS EQUIPPED WITH AN EMERGENCY LIGHT, AND MAY BE EQUIPPED WITH A FOG SIGNAL, RADIO BEACON OR RACON.

FOG SIGNAL

LIGHT COLOUR AND CHARACTER ARE ADVERTISED ON THE CHART AND IN THE PUBLICATION "LIST OF LIGHTS, BUOYS AND FOG SIGNALS". STRUCTURE COLOUR MAY NOT HAVE LATERAL SIGNIFICANCE. ELEVATION OF LIGHT ABOVE WATER LEVEL (METRES (m) OR FEET (ft)) AND NOMINAL RANGE (NAUTICAL MILES (M)) MAY BE INDICATED. EQUIPPED WITH AN EMERGENCY LIGHT OF REDUCED INTENSITY, FI(6)15s. WHEN LIGHT COLOUR IS NOT SPECIFIED FOR ANY MARINE AIDS NAVIGATION LIGHT, IT IS WHITE.

RADIO BEACON

SIGNAL CHARACTERISTICS ADVERTISED ON CHART AND IN "LIST OF LIGHTS, BUOYS AND FOG SIGNALS".

RACON

INFORMATION CONCERNING RADIO BEACONS CAN BE FOUND IN THE PUBLICATION "RADIO AIDS TO MARINE NAVIGATION." VESSELS MUST BE EQUIPPED WITH RADIO DIRECTION FINDING RECEIVERS TO USE THESE AIDS.

RACON

A RACON (RADAR BEACON) TRANSMITS A MORSE CODE PULSE THAT CAN BE SEEN ON A RADAR DISPLAY DISTINGUISHING IT FROM SURROUNDING RADAR TARGETS. INFORMATION CONCERNING RACONS CAN BE FOUND IN "RADIO AIDS TO MARINE NAVIGATION".



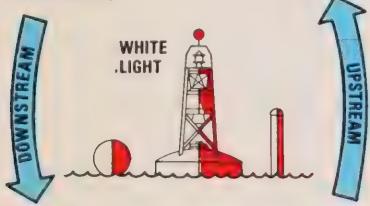
NORTH

UPSTREAM

FIG
T1
GFIR
T2
R

LATERAL BUOYS

FAIRWAY



DESCRIPTION

- RED & WHITE VERTICAL STRIPES
- WHITE LIGHT Mo(A) 6s OR (LFI) 10s (IF EQUIPPED)
- IF UNLIGHTED, IT HAS A SPHERICAL TOP
- RED SPHERICAL TOPMARK (IF EQUIPPED)
- LETTERED – NO NUMBERS
- WHITE RETROREFLECTIVE MATERIAL

0 sec 6 12

Mo (A) 6s OR

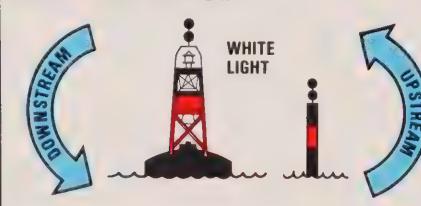
0 sec 10

LFI 10s

BELL RW RW

WHIS RW RW

ISOLATED DANGER



DESCRIPTION

- BLACK WITH ONE RED HORIZONTAL BAND
- WHITE LIGHT, GROUP FI(2) 5s OR GROUP FI(2) 10s (IF EQUIPPED)
- TWO BLACK SPHERICAL TOPMARKS
- LETTERED – NO NUMBERS
- WHITE RETROREFLECTIVE MATERIAL

0 sec 5 10 15

FI(2)5s OR

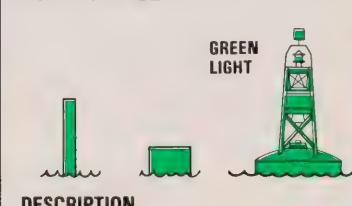
0 sec 10

BELL RW RW

WHIS RW RW

BRB BRB

PORT HAND



DESCRIPTION

- GREEN
- GREEN LIGHT (FI) 4s OR (Q) 1s (IF EQUIPPED)
- IF UNLIGHTED, IT HAS A FLAT TOP
- TOPMARK IS A SINGLE GREEN CYLINDER (IF EQUIPPED)
- LETTER(S) AND ODD NUMBER(S)
- GREEN RETROREFLECTIVE MATERIAL

0 sec 4 8 12 16

(FI) 4s OR

0 sec 5 10 15

BELL G G

WHIS G G

BRB BRB

STARBOARD



DESCRIPTION

- RED
- RED LIGHT (FI) 4s OR (Q) 1s (IF EQUIPPED)
- IF UNLIGHTED, IT HAS A POINTED TOP
- TOPMARK IS A SINGLE RED CONE, P (IF EQUIPPED)
- LETTER(S) AND EVEN NUMBER(S)
- RED RETROREFLECTIVE MATERIAL

0 sec 4 8 12 16

(FI) 4s OR

0 sec 5 10 15

BELL G G

WHIS G G

BRB BRB

USERS GUIDE

THIS BUOY INDICATES SAFE WATER. USED TO MARK LANDFALLS, CHANNEL ENTRANCES OR CHANNEL CENTERS. IT MAY BE PASSED ON EITHER SIDE BUT SHOULD BE KEPT TO THE PORT (LEFT) WHEN PROCEEDING IN EITHER DIRECTION.

USERS GUIDE

AN ISOLATED DANGER BUOY IS MOORED ON, OR ABOVE, AN ISOLATED DANGER WHICH HAS NAVIGABLE WATER ALL AROUND IT. CONSULT THE CHART FOR INFORMATION CONCERNING THE DANGER, (DIMENSIONS, DEPTH ETC.). MAY BE USED TO MARK NATURAL DANGERS SUCH AS SMALL SHOALS OR OBSTRUCTIONS SUCH AS WRECKS.

USERS GUIDE

A PORT HAND BUOY MARKS THE PORT (LEFT) SIDE OF A CHANNEL OR THE LOCATION OF A DANGER WHICH MUST BE KEPT ON THE VESSEL'S PORT (LEFT) SIDE WHEN PROCEEDING IN THE UPSTREAM DIRECTION.

USERS GUIDE

A STARBOARD HAND BUOY MARKS THE (RIGHT) SIDE OF A CHANNEL OR THE (RIGHT) SIDE OF A DANGER WHICH MUST BE KEPT ON THE STARBOARD (RIGHT) SIDE WHEN PROCEEDING IN THE UPSTREAM DIRECTION.

Buoy Type	Colour
Mooring	
Keepout	white and orange
Control	
Information	
Swimming	white
Diving	white with red and white flag

2. Buoy Shape

The shape of an unlighted buoy indicates the position of the buoy with respect to the channel and thus the side on which the buoy should be passed.

- (a) A pointed (conical) shape indicates that the buoy is marking the starboard (right) side of the channel or the location of a danger which must be kept on the vessel's starboard (right) side when proceeding upstream.
- (b) A flat top or cylindrical (can) shape indicates that the buoy is marking the port (left) side of the channel or the location of a danger which must be kept on the vessel's port (left) side when proceeding upstream.
- (c) A spherical shape indicates that the buoy is marking the centre of the channel or safe water and that it may be safely passed on either side although generally it should be kept on the vessel's port (left) side when proceeding in either direction.

3. Topmarks

The use of topmarks as an additional means of daytime buoy identification is at present, restricted to the isolated danger buoy and cardinal buoys in ice-free conditions. Topmarks are not used in Canada to the extent that they are used in other parts of the world because of the environmental conditions with which Canadian aids to navigation must cope. Mariners are cautioned not to rely solely on topmarks as a means of buoy identification as they are susceptible to damage and may be intentionally removed during winter and ice conditions.

However, the Canadian Buoyage System includes topmarks for each buoy as follows:

Buoy Type	Topmark Description
Port and Port Bifurcation	single green cylinder
Starboard and Starboard Bifurcation	single red cone, point upward
Fairway	single red sphere
Isolated Danger	2 black spheres, one above the other
North Cardinal	2 black cones, points upward
East Cardinal	2 black cones, base to base
South Cardinal	2 black cones, points downward
West Cardinal	2 black cones, point to point

NOTE: A way of remembering the arrangement of the conical topmarks on Cardinal Buoys is to relate the direction of the points of the cones to the location of the black portion(s) of the buoy (e.g. on an East Cardinal, the upper cone pointing up and the lower cone pointing down relate to the black colour of the upper and lower portions of the buoy).

NIGHTTIME IDENTIFICATION

At night, the colour and flash character of a buoy light indicate the buoy type and hence its function and interpretation by the mariner.

1. Buoy Light Flash Characters

The following are the names, abbreviations and descriptions of the flash characters of the lights used in the Canadian Buoyage System.

Name	Abbreviation	Description	Buoy
Flashing	Fl	A light in which a flash is regularly repeated at a rate of 15 flashes per minute (a flash every 4 seconds)	Port Starboard Anchorage Cautionary Mooring Keepout Control Information Swimming Diving
Quick Flashing	Q	A light in which a flash is regularly repeated at a rate of 60 flashes per minute (a flash every second)	Port Starboard North Cardinal
Very Quick Flashing	VQ	A light in which a flash is regularly repeated at a rate of 120 flashes per minute (a flash every 1/2 second)	North Cardinal
Morse "A"	Mo(A)	A light in which a short flash is followed by a long flash to form the letter "A" in the Morse Code 10 times per minute (every 6 seconds)	Fairway
Long Flash	LFl	A light in which a flash of 2 seconds duration is repeated at a rate of 6 flashes per minute (a flash every 10 seconds)	Fairway
Group Flashing(2)	Fl(2)5s or Fl(2)10s	A light in which a group of 2 flashes is regularly repeated 12 times per minute (every 5 seconds) A light in which a group of 2 flashes is regularly repeated 6 times per minutes (every 10 seconds)	Isolated Danger

Name	Abbreviation	Description	Buoy
Composite Group Flashing	Fl(2 + 1)6s or Fl(2 + 1)10s	A light in which a group of 2 flashes is followed by a single flash, the whole sequence being regularly repeated 10 times per minute (every 6 seconds) A light in which a group of 2 flashes is followed by a single flash; the whole sequence being regularly repeated 6 times per minute (every 10 seconds)	Port Bifurcation Starboard Bifurcation
Group Quick Flashing(3)	Q(3)10s	A quick flashing light in which a group of 3 flashes is regularly repeated 6 times per minute (every 10 seconds)	East Cardinal
Group Very Quick Flashing(3)	VQ(3)5s	A very quick flashing light in which a group of 3 flashes is regularly repeated 12 times per minute (every 5 seconds)	East Cardinal
Group Quick Flashing (6) plus Long Flash	(Q(6) + LFI)15s	A light in which a group of 6 quick flashes is followed by a single long flash; the whole sequence being regularly repeated 4 times per minute (every 15 seconds)	South Cardinal
Group Very Quick Flashing (6) plus Long Flash	(VQ(6) + LFI)10s	A light in which a group of 6 very quick flashes is followed by a single long flash; the whole sequence being regularly repeated 6 times per minute (every 10 seconds)	South Cardinal
Group Quick Flashing (9)	Q(9)15s	A quick flashing light in which a group of 9 flashes is regularly repeated 4 times per minute (every 15 seconds)	West Cardinal
Group Very Quick Flashing(9)	VQ(9)10s	A very quick flashing light in which a group of 9 flashes is regularly repeated 6 times per minute (every 10 seconds)	West Cardinal
Group Flashing(5)	Fl(5)20s	A light in which a group of 5 flashes is regularly repeated 3 times per minute (every 20 seconds)	ODAS

NOTE: As a way of remembering the light flash characters of the East, South and West Cardinal buoys, the number of flashes in each group for these lights is the same as the figure on the clock face in the corresponding compass direction (e.g. the 3 flashes in each group for the East Cardinal correspond to 3 o'clock). The long flash in the South Cardinal characteristic ensures that there is no confusion between the 6 flashes per group for this buoy and the 9 flashes per group of the West Cardinal.

2. Buoy Light Colour

The following are the colours of the buoy lights used in the Canadian Buoyage System:

Buoy Type	Light Colour
Port and port bifurcation	green
Starboard and starboard bifurcation	red
Fairway, Isolated danger, and all cardinals	white
All special buoys	yellow

3. Retroreflective Material

In certain waterways, retroreflective material is applied to unlighted buoys to aid in their identification at night with a flashlight or other light source. In general, the colour of the retroreflective material is the same as that of the light which would be appropriate for that buoy. Retroreflective white material may also be used for buoy numbers on both lighted and unlighted buoys.

OTHER CHARACTERISTICS

Buoy Numbering

Only starboard and port hand buoys are numbered; starboard hand buoys with even numbers and port hand buoys with odd numbers. Buoy numbers increase in the upstream direction and are kept in approximate sequence on both sides of the channel by omitting numbers where required. Buoy numbers are usually preceded by one or two letters to facilitate channel identification. All other types of buoys are identified by letters only. All types of buoys may be identified by a name in addition to a number or letter identification.

Sound

Any of the buoy types in the Canadian Buoyage System may be fitted with a bell or a whistle that is activated by the motion of the buoy in the water. The use of such buoys is generally restricted to coastal waters where there is sufficient buoy motion to activate the sound device and where there is a requirement for an audio signal to enable location of the buoy under low visibility conditions.

Radar Reflectors

Many buoys are fitted with radar reflectors to improve their visibility on the radar screen.

Radar Beacons (RACONs)

When precise identification of a buoy is considered essential, the buoy may be fitted with a radar beacon (RACON).

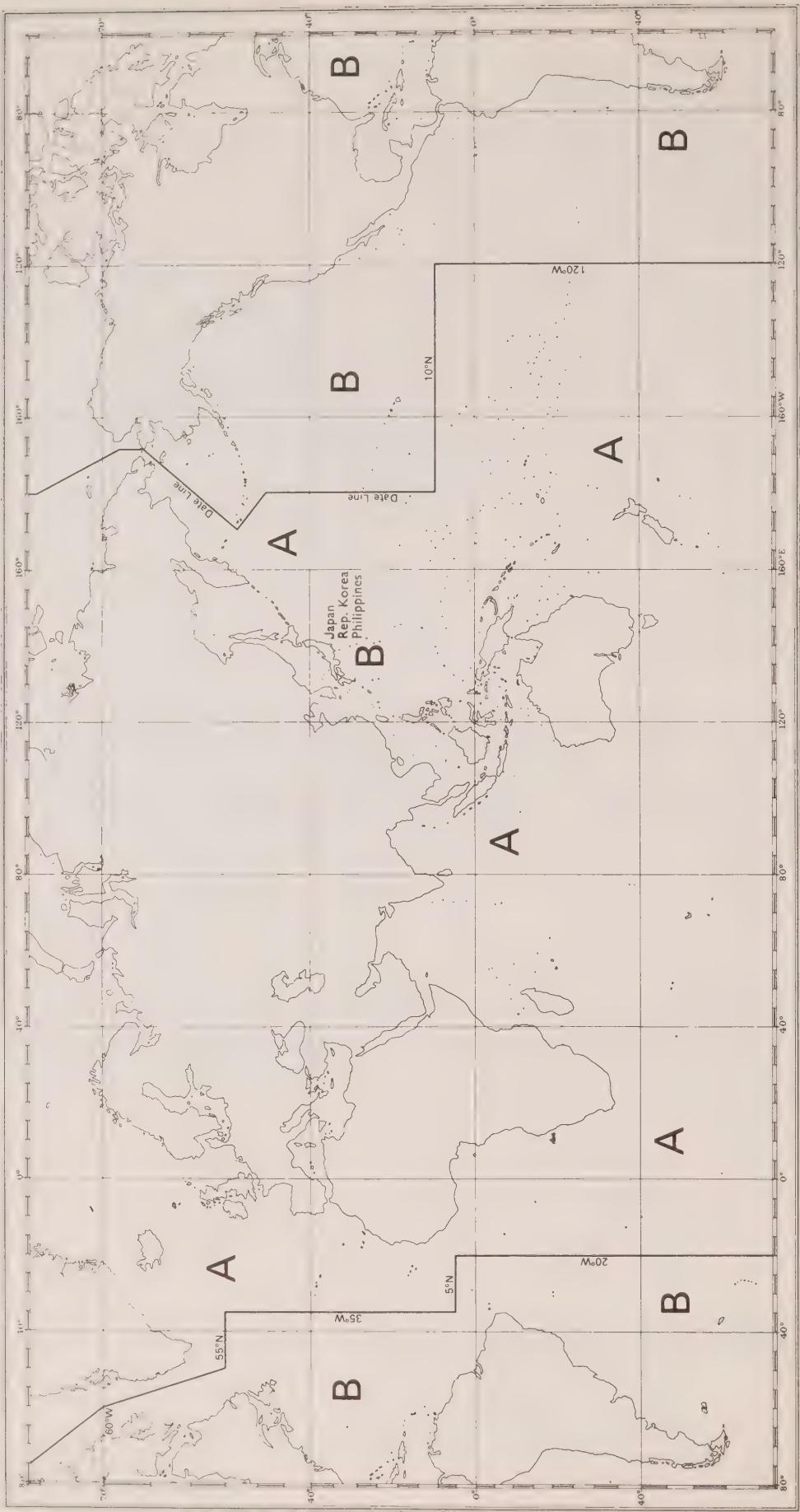
Marking of New Dangers

New dangers such as a shipwreck or the discovery of an uncharted shoal or rock can occur suddenly and unexpectedly in waters which mariners have come to regard as safe. Because of the surprise aspect of new dangers, the IALA Maritime Buoyage System and thus the Canadian Buoyage System make special provisions for the marking of them. These provisions, which are for use in especially grave situations, are:

- (a) One or more of the buoys marking the new danger may be duplicated, the duplicate being identical to its partner in all respects.
- (b) In general, any lighted lateral or cardinal buoy used to mark a new danger will display the most rapid flash character available for that buoy.
- (c) A new danger may be marked by a RACON coded Morse "D".
- (d) Special measures taken to mark a new danger may be discontinued when information concerning the new danger has been sufficiently promulgated.

IALA MARITIME BUOYAGE SYSTEM

Buoyage Regions A and B, November 1980



RADIO AIDS TO NAVIGATION

RADAR REFLECTORS AND RADAR BEACONS (RACONs)

General

The detection of a radar target is essentially dependent on the level of energy reflected back into the radar receiving antenna from the target. When an aid to navigation gives a poor radar echo, equipment may be fitted to the aid to give an enhanced echo on a radar display. There are two main methods of producing a radar enhanced target. The first is by using a passive device such as a radar reflector to enlarge the apparent echoing area of the target and the second is by the use of a radar beacon (RACON), which is an active device. RACONs can also be used to avoid confusion between radar targets that may look similar, because they produce an easily identifiable coded trace on the radar display.

Radar Reflectors

Certain fixed shore aids and most buoys are designed or equipped to enhance the aids' ability to reflect radar signals. Radar reflectors may also be established as independent aids to navigation. Independent radar reflectors are symbolized on charts and those established on lighted aids are advertised in the appropriate List of Lights, Buoys and Fog Signals publication.

Radar Beacons (RACONs)

A RACON comprises three main components: a receiver, a transmitter and an antenna common to both the receiver and the transmitter. A radar within the range of the RACON interrogates the RACON each time the radar antenna points towards the RACON. The RACON receiver amplifies the radar pulses up to a level that triggers the RACON transmitter. The transmitter may reply with a single pulse for each trigger but normally the response consists of a series of coded pulses (Morse Code) for RACON identification. After triggering, a finite time must be allowed for the RACON to respond. This results in a transmission which is delayed in time (and range) with respect to the passive echo of the structure on which the RACON is mounted. The delay is generally equivalent to a range of less than 100 metres and can, therefore, often be disregarded at ranges greater than a few nautical miles. At ranges sufficiently short that this error is significant, the station structure echo is normally visible and its range can be measured to full radar accuracy.

Radar operators may notice some broadening or spoking of the RACON presentation when their vessel approaches closely to the RACON. This effect can be minimized by adjusting the IF gain or sweep gain control of the radar (other targets will be reduced in intensity also). Caution must be exercised as the RACON presentation can be virtually eliminated by operation of the FTC (fast time constant) controls of the radar. RACON replies may also be suppressed by the operation of the automatic video processor with which some radars are equipped.

Two types of RACONs are in common use today as aids to navigation.

1. Slow Sweep RACON

In a slow sweep RACON the transmission frequency is periodically swept through the marine radar band of 9320 to 9500 MHz (3 cm or X band). Only when the frequency passes through the narrow band width of the radar receiver is the RACON signal presented on the radar display, resulting in a short presentation time (1 to 3 antenna scans) with a long delay time (45 to 120 seconds) between presentations.

2. Frequency Agile RACON

A frequency agile RACON measures the frequency and signal strength of the interrogating radar pulse, then tunes its transmitter to that frequency before responding. This RACON provides service for X band marine radars and some installations also provide service for the marine radar band of 2920 to 3100 MHz (10 cm or S band)¹. While it is possible for a response to be displayed on each antenna scan of every radar within range, in actual practice, these RACONs are programmed to turn off for a preselected period at regular intervals to prevent the masking of other echoes of interest.

The locations, codes and operating frequencies (X, S or X and S) of RACONs are published in Notices to Mariners and listed in the appropriate marine publications, i.e. Radio Aids to Marine Navigation, Sailing Directions (Pilots) and List of Lights, Buoys and Fog Signals.

RADIOBEACONS

The Canadian marine radiobeacon service consists of 82 transmitter facilities operating in the frequency band from 285 to 325 kHz.

Over the past few years, the Coast Guard has been implementing a new radiobeacon service plan. The changes brought about under this plan were designed to realign the service being provided more closely to the needs of Canadian marine users.

Under the new service plan, all Canadian radiobeacons operate in a continuous mode and provide the following categories of service:

- 1) **Landfall:** Radiobeacons having ranges from 100 to 200 nautical miles provide a means of identifying major points of land when approached from seaward.
- 2) **Homing:** Radiobeacons having ranges from 20 to 100 nautical miles provide a means of locating major harbours or ports of refuge.
- 3) **Calibration:** This is a minor service, provided by short range radiobeacons which are operated on request to provide a means of calibrating radio direction finding equipment.

The radiobeacons providing the first two categories of service may be either dedicated marine beacons or combined air/marine beacons; that is providing service to both air and marine users. The Canadian service is complemented by radiobeacons operated by the U.S. Coast Guard in contiguous waters.

All categories of radiobeacons are shown on the nautical charts and are listed in the publications "Radio Aids to Marine Navigation" and "Lists of Lights, Buoys and Fog Signals".

¹ Since 1985 all RACONs purchased by the Canadian Coast Guard have been of the frequency agile type providing service to both X and S band radars. Eventually, as older units are replaced, the Canadian RACON service will consist totally of this type.

LORAN-C

1. System Description

Loran-C is a hyperbolic radio navigation system. Such systems operate on the principle that the difference in time of arrival and/or phase of signals from two or more stations, observed at a point in the coverage area, is a measure of the difference in distance from the point of observation to each of the stations. Loran-C employs time difference measurements of signals received from at least three fixed transmitting stations. The stations are grouped to form a "chain" of which one station is labelled the master (designated M) and the others are called secondary stations (designated W, X, Y or Z).

For a given master-secondary pair of stations, a constant difference in time of arrival of signals defines a hyperbolic Line Of Position (LOP). The measurement of the received Time Difference (TD) from a second master- secondary pair results in a second LOP. The position fix is achieved by observing the intersections of the two LOP's on specially latticed Loran-C charts.

Alternatively, most Loran-C receivers sold today are equipped with microprocessors which are designed to compute and display the latitude and longitude coordinates of the receiver, based on the TDs.

Cautionary Note - The Latitude/Longitude computation in most receivers is based upon a pure seawater propagation path. This leads to errors if the Loran-C signal paths from the various stations involve appreciable overland distances which cause the signals to travel at a slower speed. It is recommended that operators using the coordinate converter feature of their receivers check the manufacturer's operating manual to determine if and how corrections are to be applied to compensate for overland paths. For those coordinate converters that can accommodate the correction (called an Additional Secondary Factor (ASF) correction) to the Time Differences, the chartlets in the Coast Guard's "Radio Aids to Marine Navigation" publication can be used to ascertain the numeric value to apply. For receivers without the coordinate converter facility, the data in the chartlets are irrelevant since these corrections are already accommodated in the lattices on charts of scale larger than 1:300,000. On smaller scale charts the small ASF corrections, although accounted for by prediction rather than measurement, are not usually discernible.

The transmitting stations of a Loran-C chain transmit groups of pulses which are repeated at a specific interval called the "rate" or the Group Repetition Interval (GRI). Each pulse has a 100 kHz carrier frequency. The secondary stations transmit 8 pulses to a group, while the master station transmits an extra ninth pulse which is used for receiver automatic acquisition and blink alarm. The Loran-C rate structure is such that a GRI of between 40,000 and 99,990 microseconds is chosen for a chain. The GRI is used to identify a particular Loran-C chain. The designation of a Loran-C chain is by the first four digits of the specific GRI. For example, the Canadian West Coast Chain has a GRI of 59,900 microseconds and is designated Rate 5990, while the Canadian East Coast Chain has a GRI of 59,300 microseconds and is designated Rate 5930.

2. Range

Different Loran-C stations radiate different peak powers. These typically vary from 300 kilowatts to 2 megawatts. This results in ground wave coverage ranges in the order of 700 to 1,000 nautical miles over seawater. During periods of good propagation, this range may be greater, and during periods of high noise and interference, it may be less. The signal range from a particular station is dependent upon the transmitter power, receiver sensitivity, noise or interference levels, and losses over the signal path.

3. Blink

It is normal for Loran-C stations to transmit a "blink" signal (turning off and on the master's ninth pulse or a secondary's first two pulses) whenever certain key operational parameters (output power, TDs, GRI, etc) are known, or suspected, to be out of tolerance.

The blink signal will cause most receivers to indicate by an alarm that the navigation data displayed may be in error.

Mariners should check equipment manuals to determine if their receivers are equipped with a Blink Alarm and, if not, should exercise caution when operating near known hazards or in narrow channels.

4. Receiver Installation

Proper installation of a Loran-C receiver is critical to good performance. Proper installation requires time and skill and should be done by a competent, factory-trained dealer. Antenna location, grounding, interference suppression, and receiver placement are all important.

NOTE: See the Coast Guard publications "Loran C Receiver Installation and Maintenance Guide" and "Loran C Receiver Operations Guide" listed on page 31.

5. Receiver Cautionary Note

In a few Loran-C receivers, an abnormality in the Time Difference readings may occur when the user is crossing a certain Line of Position. If such a receiver is operating in an area where the Most Significant Digit (MSD) of the TD reading must change by one digit (e.g. a reading of 29,999 microseconds changing to 30,000 microseconds), the receiver TD display will go blank. This abnormality is caused by the TD selector switch resting, in this particular example, on the MSD "2" which, in certain receivers, prevents the internal circuitry of the receiver from displaying any TDs which start with the MSD "3". If the receiver display goes blank during such an occurrence, the user must select the correct MSD before the correct TD can be displayed. Possibly a reacquisition on the Loran-C chain may be necessary. All Loran-C users are cautioned to check their receiver operating manual and/or contact their service representative to determine if their Loran-C receiver is subject to such an abnormality.

6. Baseline Extension Zone

The accuracy of the position line obtained from a particular Loran-C reading deteriorates as the ship moves from the closely spaced lattice lines in the vicinity of the baseline between the master and that particular station, towards the extension of this baseline beyond the master or the secondary station concerned. Baseline extensions are marked with a pecked line on Canadian charts. Within a zone extending about 20 microseconds each side of the baseline extension, the readings on that station pair will respond very sluggishly to a large change in position and are useless for navigation.

When crossing any baseline extension zone the reading will at some stage reach a minimum (on a secondary extension) or a maximum (on the master extension). This reading, when compared to the value marked on the charted extension line, gives a useful check on the accuracy of the system and can be used to verify cycle selection.

7. Errors in the Readings

(i) Land Path Errors

Fixed errors are introduced when the signal path from a station passes over land. The Canadian Hydrographic Service corrects these errors when producing Loran-C charts by adjustment of the hyperbolic position lines.

Caution - The conversion to latitude and longitude provided as a feature of most receivers seldom includes accurate land path corrections and may, consequently, give a position several miles in error. It is recommended that operators using the conversion feature of their receiver check the manufacturer's operating manual to determine if and how corrections are to be applied to compensate for overland paths.

(ii) Cycle Selection Errors

After determining the basic position by a time of arrival calculation, Loran-C derives its high accuracy from comparing the phase of the secondary signal against that of the master. The receiver automatically selects the third cycle of the pulse from each station to make this phase comparison; the third cycle is used because it occurs early enough in the groundwave pulse to avoid skywave contamination. Within the area of good coverage, errors in cycle selection are very rare, but at longer ranges the receiver may select the fourth cycle on first acquiring a weak signal. This will cause an error in the reading of exactly 10 microseconds, moving the position line one mile or more. The likelihood of cycle selection error at long range is increased by:

- (a) Local radio interference which frequently is encountered in port;
- (b) Shielding of the antenna, for example, by dockside buildings;
- (c) Precipitation static, which occurs at the onset of snow flurries, rain showers or wet fog;
- (d) Icing, or a coating of dirt, on the antenna or antenna coupler;
- (e) Skywave interference by night, and particularly at dawn and dusk. (Note - Skywave interference does not affect Loran-C within the area of good coverage, but only at longer ranges.)

Cycle selection error is most likely to occur on the most distant station being used. If this should be the master, the result will probably be that all time difference readings will be 10 microseconds low. If the secondary is at a greater distance than the master, then it is more likely to have a cycle selection error and the corresponding time difference will be 10 microseconds high. The receiver handbook will describe the remedy once the problem station has been identified.

Initial cycle selection should be verified by an independent fix whenever possible. It is then advisable to switch the receiver into the "Tracking" mode, since the receiver will track without cycle jump to a much greater distance than that at which it will make a reliable cycle selection. Some receivers go into "Track" mode automatically upon completing cycle selection.

(iii) Shore Proximity Errors

Both the strength of the Loran-C signal and the accuracy of the reading will change rapidly close to shore, particularly near cliffs. Local reading errors may amount to one microsecond or more. However, the error will not change, and once the Loran-C readings are known for a particular inshore passage, then they can be safely used during future transits of that passage.

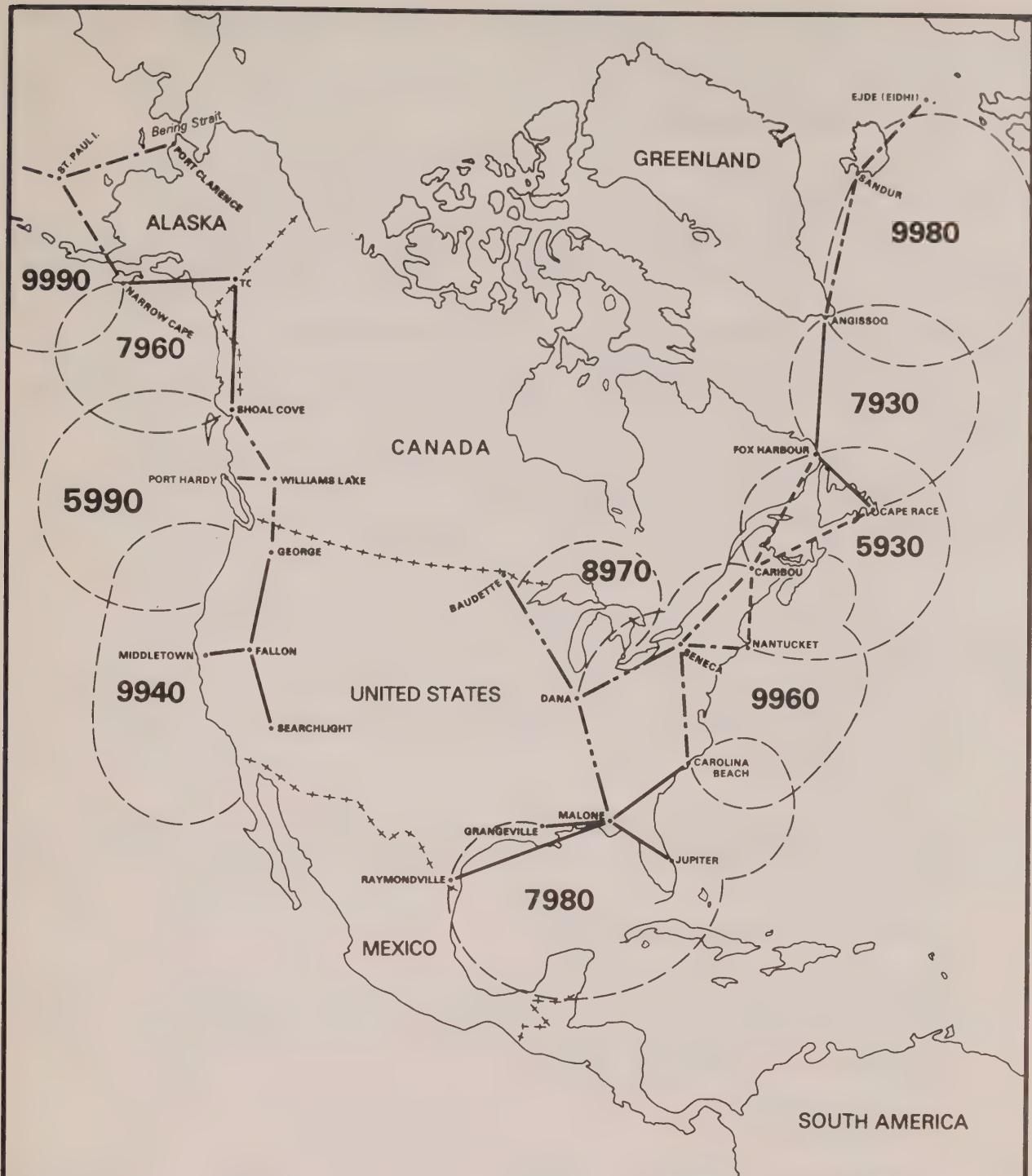
As with any radio aid to navigation, there will be some locations, such as close-in under cliffs or alongside dock buildings, where the Loran-C signal cannot be received.

8. Microprocessor-Based Receivers

Virtually all of the Loran-C receivers made today incorporate microprocessors. These are very superior to the first generation of receivers designed when Loran-C first became available for public use. The original receivers basically could only track and display two LOPs, as well as providing alarms for loss of lock, weak signals and station blink. Features in today's receivers include, for example, the ability to track all secondary stations simultaneously (even though only two are displayed), conversion of TDs to latitude and longitude, waypoint navigation (course, speed, range, bearing, time-to-go, cross track error, clock, anchor watch and boundary alarm) as well as the standard loss-of-lock, weak-signal and blink alarms.

The ability to track all secondary stations at the same time is a useful feature when one is travelling from one coverage area to another within the same chain. With the older receivers, it was frequently necessary to perform a new chain acquisition when the operator wanted to change to a different secondary station in the same chain. This deprived the user of navigational data for a period of 5-10 minutes before the receiver locked on and extinguished all alarms. Many of today's receivers can track all secondary stations simultaneously (providing they are within range) and can display any desired station pair at the touch of a button.

Cautionary Note - Micro processing units calculating courses between waypoints display great circle, NOT rhumb-line tracks. The difference between the two tracks (track offset) can be significant depending on the vessel's course, latitude and length of track. Mariners planning to navigate in the waypoint mode should take this information into account when laying off their courses for a long voyage.



NORTH AMERICAN COVERAGE OF
LORAN - C CHAINS

RELATED PUBLICATIONS AND SOURCES

RELATED PUBLICATIONS

1. Safe Boating Guide:

A valuable source of information for all boat operators. Contains information on equipment requirements, safety practices, operating regulations and other sources of nautical information. (Free) (Source 1)

2. Catalogues of Nautical Charts and Related Publications:

Identify the available nautical charts, explain the various categories of charts, list local chart distributors and give instructions for ordering. Also contain information concerning other related publications. (Free) (Source 2)

Catalogue 1	-	Atlantic Coast (Montreal - East)
Catalogue 2	-	Pacific Coast
Catalogue 3	-	Great Lakes (Manitoba to Montreal)
Catalogue 4	-	Arctic

A price list of all non-free Canadian publications is included with the above catalogues.

3. Chart No. 1:

Symbols and Abbreviations used on Canadian Nautical Charts: (Source 2)

4. Sailing Directions:

These publications give detailed descriptions of various waterways, including pictures of some harbour entrances, facilities available, etc. They are listed in the Catalogues of Nautical Charts at various prices. (Source 2 or 4)

5. Radio Aids to Marine Navigation:

Published annually in 2 volumes. Provides information concerning marine weather forecast areas and radio navigational aids services. Also lists the services provided by Canadian Coast Guard Radio Stations, vessel traffic and information services and the location and characteristics of marine radio aids to navigation, i.e. Loran-C, Radiobeacons and RACONs. (Source 4)

Atlantic & Great Lakes (Eng. & Fr.)
Pacific (English only)

6. Lists of Lights, Buoys and Fog Signals:

Published annually, usually early March in four volumes. Contain information on the characteristics and position of shore lights, lighted buoys and fog signals. Available in English and French at various prices. (Source 2 or 4)

Newfoundland (includes coastal Labrador)
Atlantic Coast (includes Gulf & River St. Lawrence to Montreal)
Inland Waters (west of Montreal, east of B.C.)
Pacific Coast (includes rivers & lakes of B.C.)

7. A Primer on Loran-C:

Describes the basic characteristics of the Loran-C radionavigation system and provides information on its use. (Free) (Source 3)

8. LORAN-C Receiver Operations Guide

This Guide gives the mariner a few helpful hints on using his Loran-C receiver so that he can derive the maximum benefit from it. (Free) (Source 3)

9. LORAN-C Receiver Installation & Maintenance Guide

The information in this Installation and Maintenance Guide has been collected from many sources to provide dealers, installers and owners of Loran-C receivers with a handy reference. (Free) (Source 3)

10. Notices to Shipping:

Radio broadcasts issued through Coast Guard Marine Radio Stations. These broadcasts contain a variety of information that affect the immediate safety of the mariner (e.g. malfunction of aids to navigation, new hazards, changes to aids). Written copies of these broadcasts are available from Coast Guard Regional Offices. (Free) (Source 6 for subscription)

11. Weekly Notices to Mariners:

Published weekly. Contain important navigational information such as changes in aids to navigation, new hazards, amendments to nautical charts, Sailing Directions, Lists of Lights, Buoys and Fog Signals, Radio Aids to Marine Navigation. They also advertise publication of new charts and new editions of charts and publications. (Free) (Source 3 for subscription)

12. Annual Notices to Mariners:

Published annually at the beginning of each year. Contains information on a wide variety of subjects of concern to the mariner. Subjects covered include: (Free) (Source 3)

- aids to navigation
- military exercise areas
- marine regulations
- casualty reporting
- pollution
- radiotelephone practices
- vessel traffic services
- search and rescue
- charts
- marine safety

13. Tide and Current Tables:

Published annually in six volumes and two consolidated editions. Contains daily tide predictions for all Canadian reference ports along with tidal differences for secondary ports. Daily current predictions are also included for selected current stations. They are listed in the Catalogue of Nautical Charts at various prices. (Source 2 or 4)

Volume 1	-	Atlantic Coast and Bay of Fundy
Volume 2	-	Gulf of St. Lawrence
Volume 3	-	St. Lawrence and Saguenay Rivers
Volume 4	-	Arctic and Hudson Bay
Volumes 1-4	-	Atlantic Coast
Volume 5	-	Juan de Fuca and Georgia Straits
Volume 6	-	Barkley Sound and Discovery Passage to Dixon Entrance
Volume 5-6	-	Pacific Coast

14. Provincial Directories of Safe Boating Courses:

These directories list recreational boating organizations and fisheries colleges throughout each province and describes the courses they offer on safety, instructor training and skills development. Please indicate the province and official language (Eng. or Fr.) requested. (Free) (Source 5)

15. Directory of Safe Boating Information Sources:

This directory lists safe boating information (pamphlets, videos, educational tools, etc.) and describes their content, language, costs and where they may be obtained. (Free) (Source 5)

16. Collision Regulations:

An office consolidation of the "International Regulations For Preventing Collisions at Sea, With Canadian Modifications" (Source 2 or 4)

NOTE: The prices of all non-free publications are included with Catalogues of Nautical Charts and Related Publications.

SOURCES OF RELATED PUBLICATIONS

1. Public Affairs
Transport Canada
Place de Ville, Tower C
21st Floor
Ottawa, Ontario
K1A 0N5
2. Hydrographic Chart Distribution Office
Fisheries and Oceans Canada
P.O. Box 8080
1675 Russell Road
Ottawa, Ontario
K1G 3H6

Note: Telephone orders for C.H.S. charts and publications may be placed (Visa and Mastercard accepted) by calling (613) 998-4931. Charts and related publications are also available from local chart distributors.

3. Aids and Waterways
Canadian Coast Guard
Canada Building (6th Floor)
344 Slater Street
Ottawa, Ontario
K1A 0N7

Note: Most Canadian Coast Guard publications are also available from Coast Guard District and Regional Offices.

4. Printing and Publishing
Supply and Services Canada
Ottawa, Ontario
K1A 0S9
5. Search and Rescue Branch
Canadian Coast Guard
Canada Building (7th Floor)
344 Slater Street
Ottawa, Ontario
K1A 0N7

6. CANADIAN COAST GUARD AIDS TO NAVIGATION OFFICES

NEWFOUNDLAND REGION:

ST. JOHN'S, NFLD.	REGIONAL DIRECTOR GENERAL, P.O. Box 1300, St. John's, Nfld. A1C 6H8 Tel: 1-709-772-5164 1-709-772-2083
Traffic Centre	
GOOSE BAY, LAB.	DISTRICT MANAGER, P.O. Box 28, Goose Bay, Lab. A0P 1C0 Tel: 1-709-896-2569

MARITIMES REGION:

DARTMOUTH, N.S.	REGIONAL DIRECTOR GENERAL, P.O. Box 1013, Dartmouth, N.S. B2Y 4K2 Tel: 1-902-426-3939
CHARLOTTETOWN, P.E.I.	DISTRICT MANAGER, P.O. Box 1270, Charlottetown, P.E.I. C1A 7M8 Tel: 1-902-566-7935
Information Centre	1-902-426-6030 (Nights and Holidays)

DARTMOUTH, N.S.

DISTRICT MANAGER,
P.O. Box 1000,
Dartmouth, N.S. B2Y 3Z8
Tel: 1-902-426-3800
Information Centre 1-902-426-6030 (Nights and Holidays)

SAINT JOHN, N.B.

DISTRICT MANAGER,
P.O. Box 7730, Station 'A',
Saint John, N.B. E2L 4X6
Tel: 1-506-648-4703
Information Centre 1-902-426-6030 (Nights and Holidays)

LAURENTIAN REGION:

QUÉBEC, QUE.

REGIONAL DIRECTOR GENERAL,
104 Rue Dalhousie,
Québec, Que. G1K 4B8
Tel: 1-418-648-3420
Information Centre 1-514-866-1584 (Nights and Holidays)
(Montreal) 1-800-361-7770

SOREL, QUE.

Tel: 1-514-743-7931

CENTRAL REGION:

TORONTO, ONT.

REGIONAL DIRECTOR GENERAL,
1 Yonge St., 20th Floor,
Toronto, Ont. M5E 1E5
Tel: 1-416-973-3057
1-519-332-0744 (Nights and Holidays)

Traffic Centre
(Sarnia)

PREScott, ONT.

DISTRICT MANAGER,
P.O. Box 1000,
Prescott, Ont. K0E 1T0
Tel: 1-613-925-2865

AMHERSTBURG, ONT.

SUB-DISTRICT MANAGER,
370 Dalhousie St.,
Amherstburg, Ont. N9V 1X3
Tel: 1-519-736-5449

PARRY SOUND, ONT.

DISTRICT MANAGER,
P.O. Box 310,
Parry Sound, Ont. P2A 2X4
Tel: 1-705-746-2196

THUNDER BAY, ONT.

SUB-DISTRICT MANAGER,
P.O. Box 2746,
Thunder Bay 'P', Ont.
P7B 5G2
Tel: 1-807-345-6311

KENORA, ONT.

SUB-DISTRICT MANAGER,
P.O. Box 649,
Kenora, Ont. P9N 3X6
Tel: 1-807-468-6441

SELKIRK, MAN.

SUB-DISTRICT MANAGER,
P.O. Box 216,
Selkirk, Man. R1A 2B2
Tel: 1-204-482-5813

WESTERN REGION:

VANCOUVER, B.C.

REGIONAL DIRECTOR GENERAL,
800 Burrard St.,
Vancouver, B.C. V6Z 2J8
Tel: 1-604-984-3720
1-604-666-6321
Information Centre 1-604-922-2433 (Nights and Holidays)

VICTORIA, B.C.

DISTRICT MANAGER,
25 Huron Street,
Victoria, B.C. V8V 4V9
Tel: 1-604-388-3186

PRINCE RUPERT, B.C.

DISTRICT MANAGER,
P.O. Box 3670,
Prince Rupert, B.C. V8J 3W8
Tel: 1-604-624-9146

HAY RIVER, N.W.T.

DISTRICT MANAGER,
P.O. Box 5002,
Hay River, N.W.T. X0E 0R0
Tel: 1-403-874-5550

UNITED STATES

Aids to Navigation, Boating Information:

U.S. Coast Guard publications concerning aids to navigation may be obtained at all U.S.C.G. District Offices or by writing:

U.S. Coast Guard Headquarters (GNSR)
Washington, DC
20593

Charts:

U.S. charts may be purchased from local distributors in both the United States and Canada.

National Ocean Service nautical chart catalogues and lists of NOS sales agents (in the U.S. and Canada) are available (free) by writing:

National Ocean Service, Distribution Division (N/CG33)
6501 Lafayette Ave.
Riverdale, MD
20737-1199

U.S. charts and related publications may also be purchased from the above address. Mail orders must be accompanied by a cheque or money order payable (in U.S. funds) to N.O.S., Department of Commerce. Telephone orders may be placed (Visa and Mastercard accepted) by calling (301) 436-6990.

The limits and numbers of U.S. charts along the Seaway/Great Lakes can also be found in Canadian Hydrographic Service Chart Catalogue 3.

